FINAL REPORT

Assessment of Geology, Energy, and Minerals (GEM) Resources

CASTLE ROCK GEM RESOURCE AREA

(OR-032-15)

GRANT, HARNEY, and MALHEUR COUNTIES, OREGON

Prepared for

United States Department of the Interior
United States Bureau of Land Management
Scientific Systems Development Branch

March 1983

TERRADATA
...on Street
...isco, CA
...36
...-2063

TERRADATA
7555 West 10th Avenue
Lakewood, CO 80215
(303) 237-7462

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(OR - 032 - 15)
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Prepared For:

United States Department of the Interior
United States Bureau of Land Management
Scientific Systems Development Branch

By

Geoffrey W. Mathews
William H. Blackburn
D. Lynne Chappell

TERRADATA

Bureau of Land Management Project Direction:

Jean Juilland, Project Manager, Scientific Systems Development Branch
Durga Rimal, COAR, BLM State Geologist, Oregon
Larry Steward, BLM State Geologist, Nevada
Ted Holland, BLM State Geologist, Idaho

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This report was prepared as part of a Phase I Assessment of GEM Resources within designated Wilderness Study Areas in Oregon, Idaho and Nevada.

TERRADATA
7555 West Tenth Avenue, Suite 200, Lakewood, Colorado 80215
303 - 237 - 7462

TERRADATA
San Francisco
Denver

DISCLAIMER

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- Dr. Antonius Budding - Oil Shale and Tar Sands
- Mr. Raymond Corcoran - Field Verification
- Dr. James Firby - Paleontology
- Mr. Ralph Mason - Coal
- Mr. Richard Miller - Uranium and Thorium
- Mr. Vernon Newton - Oil and Gas
- Mr. Herbert Schlicker - Industrial Minerals and Geologic Hazards
- Dr. Walter Youngquist - Geothermal
- Dr. Paul Weis - Metals and Non - Metals.

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Ms. Pamela Ruhl provided clerical and editorial assistance throughout the project. Ms. Sara Mathews assisted with occurrence information and drafting. Mr. Philip R. Jones and Mr. Michael A. Becker produced all documents relating to the project using TERRADATA's word processing and document production systems.

EXECUTIVE SUMMARY

The purpose of this project is to evaluate and classify environments favorable for the occurrence of GEM resources in southeastern Oregon, southwestern Idaho, and northern Nevada. **(See the TERRADATA report entitled "Procedures for the Assessment of Geology, Energy, and Minerals (GEM) Resources.")** GEM resource environments have been rated on a scale that ranges from one to four, with one being least favorable and four being most favorable. Favorability classes two and three represent low and moderate favorability, respectively. Confidence levels range from A to D with A being low confidence and D being high confidence. The confidence levels are directly related to the quantity and quality of the information available for the determination of the favorability classes.

The specific area with which this report deals is the Castle Rock GEM resource area (GRA OR-032-15) which is located in eastern Oregon (see location map, below). The GRA contains about 324 square miles within Townships 16S through 19S and Ranges 34E through 39E. It contains three WSAs (WSA 2-14, WSA 3-18, and WSA 3-27) which comprise 31,560 acres. The study area is in the Riley and Northern Malheur Resource Areas of the Burns and Vale BLM Districts. It is about 45 miles from Burns, Oregon.

The Castle Rock GRA is within the Blue Mountains section of the Central Highlands physiographic sub-province. Paleozoic eugeoclinal sediments may occur at depth. However only Tertiary volcanogenic units and Quaternary deposits are exposed within the study area. The majority of the area is underlain by the Tertiary Picture Gorge Basalt. The major structural element in the area is the Columbia Arc and associated Columbia Embayment. The Castle Rock GRA contains several geologic environments that are variously favorable for GEM resources. The study area is classified 3C for the occurrence of oil and gas resources. The 3C rating signifies that the geologic environment, the inferred geologic processes and the reported mineral occurrences indicate moderate favorability for the occurrence of oil and gas, and that the available data provide direct evidence but are quantitatively minimal to support the existence of oil and gas. The study area also contains environments similar to those found in other Tertiary basins in which diatomite deposits occur. The classification of the area for potential diatomite and agate resources (3A) signifies that although the necessary geologic environment is believed to be present, there is no evidence to support or refute this evaluation.

GRA Location Map

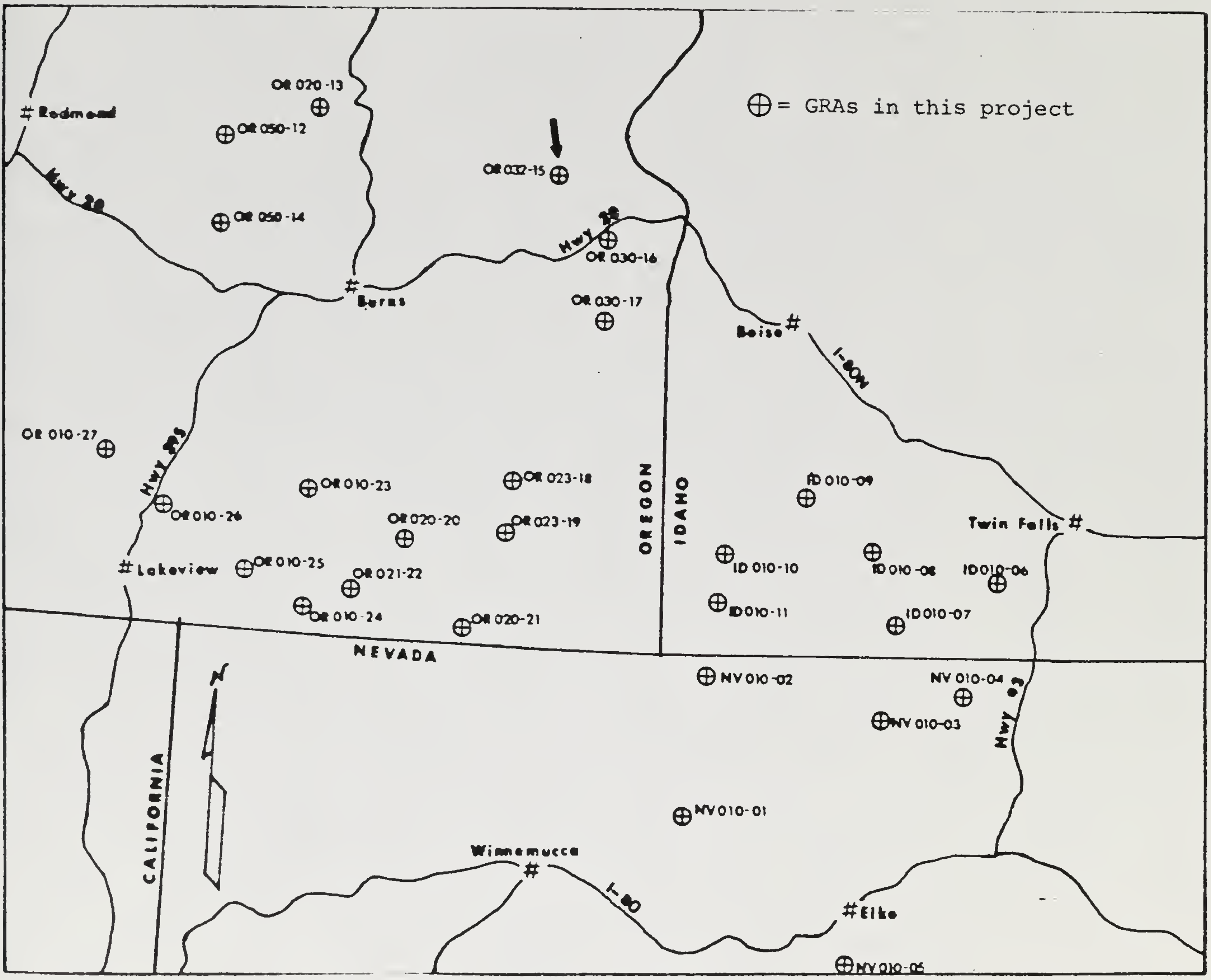
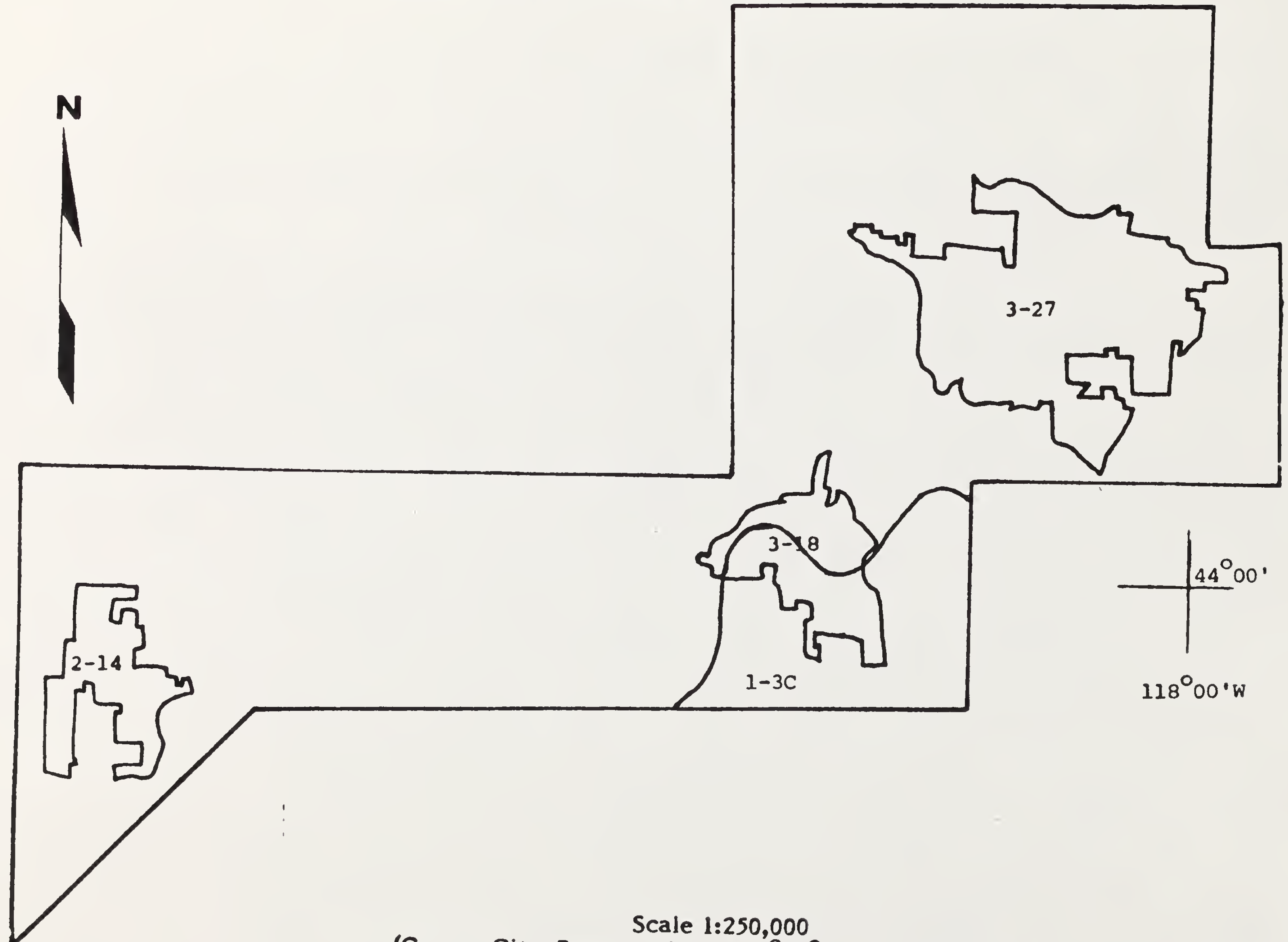


FIGURE 4-1

Land Classification Map
Castle Rock GRA
(OR-032-15)
Grant, Harney, and Malheur Counties Oregon



Scale 1:250,000
(Canyon City, Burns, and Baker 1°x2° NTMS Quadrangles)

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Classification Of Lands Within The Castle Rock GRA (OR - 032 - 15) Grant, Harney and Malheur Counties, Oregon For GEM Resource Potential

COMMODITY	AREA	CLASSIFICATION LEVEL	CONFIDENCE LEVEL	REMARKS
Metals	Entire GRA	1	A	
Geothermal	Area 1-3C	3	C	
	Rest of GRA	1	B	
Uranium/Thorium	Entire GRA	1	A	
Coal	Entire GRA	2	B	
Oil and Gas	Entire GRA	3	B	
Tar Sands/Oil Shale	Entire GRA	1	C	
Limestone	Entire GRA	1	C	
Bentonite	Entire GRA	2	A	
Diatomite	Entire GRA	3	A	
Clinoptilolite	Entire GRA	2	C	
Agate	Entire GRA	3	C	
Paleontology	Entire GRA	2	A	
Hazards	See Hazards Map (GRA File)			
ESLs	None	1	C	

LEGEND:
Class 1 - Least Favorable
Class 2 - Low Favorability
Class 3 - Moderate Favorability
Class 4 - High Favorability

Confidence Level A - Insufficient data or no direct evidence
Confidence Level B - Indirect evidence available
Confidence Level C - Direct evidence but quantitatively minimal
Confidence Level D - Abundant direct and indirect evidence

The Castle Rock GRA has one area (Area 1-3C on the Land Classification Map and Table, above) that has moderate favorability for geothermal resources. This area includes the southern portion of WSA 3-18. The presence of converging faults and hot springs activity south of the WSA suggest the existence of favorable environments in the area.

The entire GRA has low favorability for coal, bentonite, clinoptilolite, and paleontological resources. The potential for bentonite resources is classified 2A because of the possibility of alteration of rhyolitic rocks in the area. Coal resources are classified as 2B because of historical reports of small lignite beds in the area. Clinoptilolite resources are classified 2C because ash-flow tuffs could provide the requisite environments for the formation of this resource.

TERRADATA recommends that further surface geologic investigations be undertaken in the Castle Rock GRA in order to increase confidence levels in the classifications. Detailed geologic mapping and geochemical investigations would be useful in upgrading the resource potential classification of this area. Selective drilling of geochemical and/or geophysical anomalous areas would contribute to the refinement of the confidence level and favorability rating in this GRA.

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1. INTRODUCTION

This report is one of 27 GRA technical reports that summarize the results of a Phase I assessment of the geology, energy, and minerals (GEM) resources in selected portions of southeastern Oregon, southwestern Idaho, and northern Nevada. The study region was subdivided into 27 GEM resource areas (GRAs), principally for ease of data management and interpretation. The assessment of GEM resources for this project consisted of an interpretation of existing literature and information by experts knowledgeable in both the geographic area and specific commodities. It is possible that the assessment would be different if detailed field exploration, geochemical sampling, and exploratory drilling programs were undertaken. (See the TERRADATA report entitled "Procedures for the Assessment of Geology, Energy, and Minerals (GEM) Resources.")

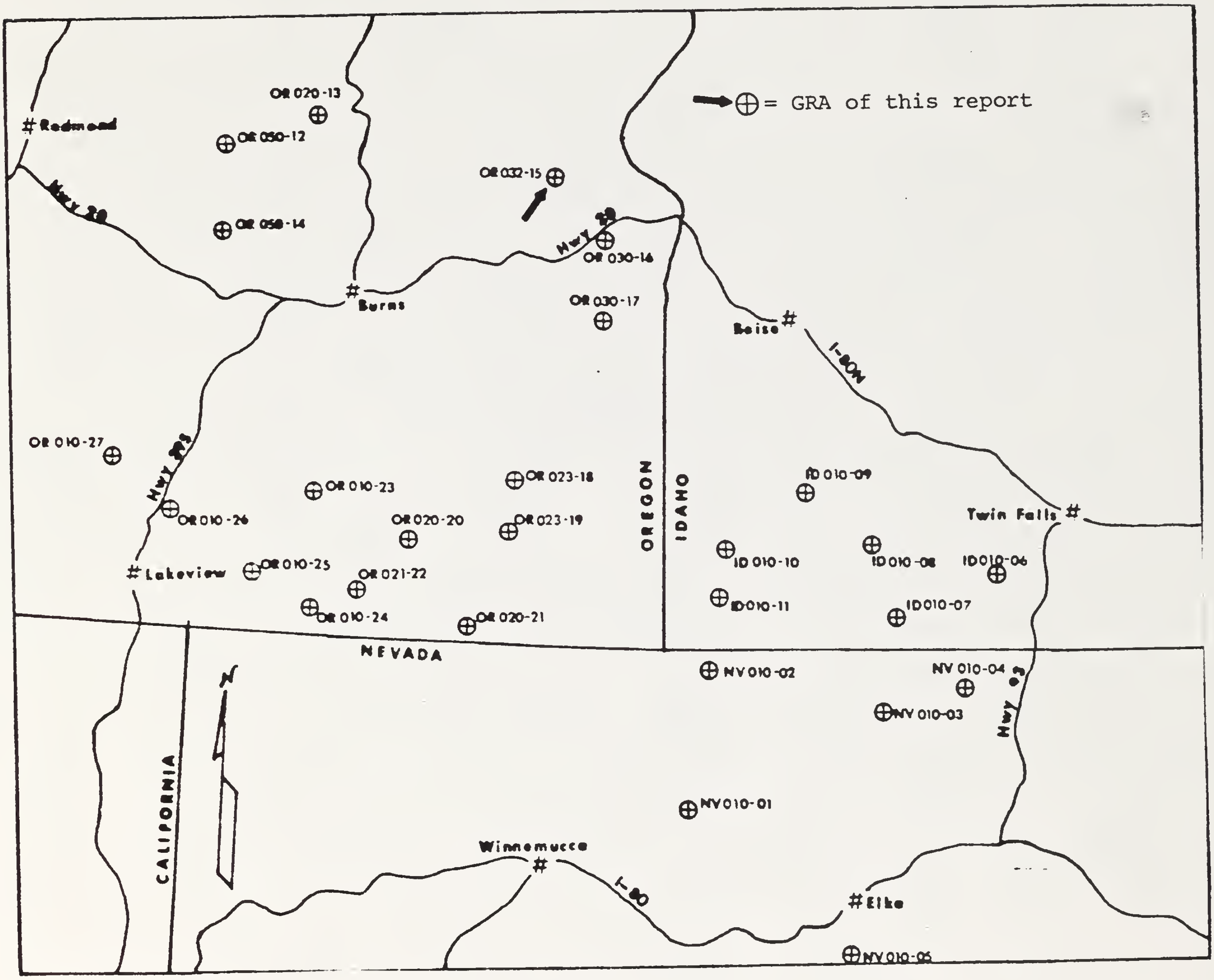
This report summarizes the assessment of the GEM resources potential of the Castle Rock GRA (OR-032-15). See Figure 1-1. Commodity categories for which this GRA was evaluated are:

- o Metals
- o Oil and Gas
- o Oil Shale and Tar Sands
- o Geothermal
- o Uranium and Thorium
- o Coal
- o Industrial Minerals
- o Paleontological Resources
- o Geologic Hazards
- o Educational and Scientific Localities (ESLs)

Geologic environments within the Castle Rock GRA have been rated with respect to their favorability for the occurrence of these different commodities. The favorability rating scale ranges from one to four, with one being least favorable and four being most favorable. Confidence levels in these ratings also have been assigned. These confidence levels range from A to D, with A being low confidence and D high confidence. Assigned confidence levels are related to the quantity and quality of the information available for the determination of the favorability ratings.

FIGURE 1-1

GRA Location Map



2. DESCRIPTION OF THE CASTLE ROCK GRA

2.1 LOCATION

The Castle Rock GRA (OR-032-15) is in eastern Oregon. It lies between latitudes 43°54'N and 44°10'N and longitudes 117°57'W and 118°35'W. The GRA contains approximately 324 square miles within Townships 16S through 19S and Ranges 34E through 39E (see Figures 1-1 and 2-1). The area contains three Wilderness Study Areas; WSA 2-14 (5,560 acres), WSA 3-18 (7,100 acres), and WSA 3-27 (18,900 acres). The Castle Rock GRA is in the Riley and Northern Malheur Resource Areas of the Burns and Vale BLM Districts. The area is about 45 miles from Burns, Oregon which is the nearest transportation center offering a minimum of rail, highway, and/or charter-air services. Access to the contained WSAs is via county maintained dirt or packed-gravel roads. Vehicular access to the interior of the WSAs is poor to non-existent.

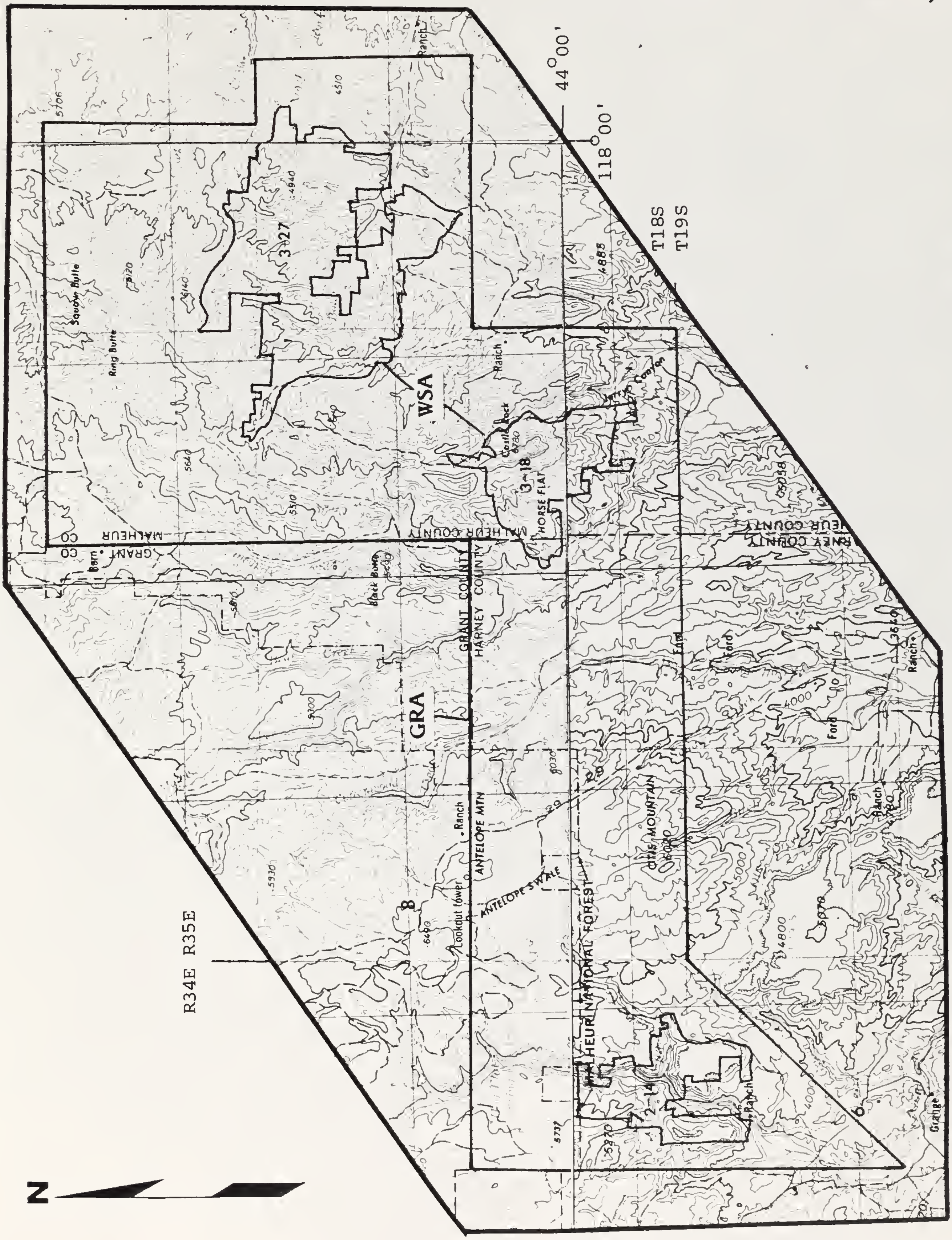
2.2 GENERAL GEOLOGY

The Castle Rock GRA is in the Canyon City, Burns, and Baker 1°x2° NTMS Quadrangles. The data available for this area includes NURE investigations[1, 2, 3, 4, 5]*, general mineral resource information[6], and limited small-scale geologic mapping[7]. Occurrence information evaluated for this GRA includes CRIB, MILS, and NURE databases, as well as claims and lease data supplied by the BLM. In general, the overall quality of commodity-specific information is fair. However, general geologic data for this area ranges from poor to fair. There are no known occurrences of most GEM resources in or near this GRA.

The Cascade Range divides the State of Oregon along the 121st meridian. The area west of this natural divide is fairly well known because of comprehensive geologic mapping published by the USGS in cooperation with the Oregon Department of Geology and Mineral Industries[7].

* In this report, citations are superscripted numbers. They refer to bibliographic entries listed in Appendix A, References Cited.

Topographic Map
Castle Rock GRA
(OR-032-15)
Grant, Harney and Malheur Counties, Oregon



Scale 1:250,000
(Canyon City, Burns, and Baker 1°x2° NTMS Quadrangles)

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The Castle Rock GRA is within the Blue Mountain section of the Central Highlands physiographic sub-province[8]. The area is typified by faulted synclinal basins and adjacent monoclinal mountain ranges. The Blue Mountain region includes, from east to northeast, the Ochoco, Strawberry, Greenhorn, Elkhorn, Wallowa, and Blue Mountains. Maximum relief is nearly 8,000 feet, but local relief varies from 2,000 feet to 5,000 feet.

The Blue Mountain section is divided into two distinct sub-groups by Dixie Mountain. The sub-group east of Dixie Mountain comprises the Wallowa-Seven Devils volcanic arc terrane, oceanic crustal terrane, forearc basin, and the Huntington volcanic arc terrane. These units lie in four sub-parallel belts that are interpreted to be remnants of acreted mini-plates[9]. The sub-group west of Dixie Mountain is composed of Paleozoic age ophiolite series and Mesozoic clastic sequences. Mesozoic and Cenozoic units are the only rocks exposed within the Castle Rock GRA.

2.2.1 Geomorphology

The Castle Rock GRA is drained by several southeast-flowing rivers. Bear Creek, Little Malheur Creek, Lost Creek, and Hunter Creek drain into the Beulah Reservoir. There are several valleys in the central and eastern portions of the GRA. The area west of Antelope Swale is a flat plateau that rises 1,000 feet above the valley floor. This area consists of precipitous cliffs capped by the Strawberry Volcanics. It is in an early stage of landform development. Streams exhibit a radial drainage pattern arond Antelope Mountain.

The area east of the Antelope Swale is in a more mature stage of landform development, which is reflected in the large percentage of the area that is in slope. The irregular topography is characteristic of an active degredational geomorphic regime. Lower order streams near Castle Rock exhibit a trellis drainage pattern.

Total relief in this area ranges from a high point of 6,780 feet in the east-central part of the area, at Castle Rock, to the lowest point, 3,600 feet, near Cottonwood Creek.

Although published maps of the area show few faults, LANDSAT imagery interpretation[12] and stratigraphy suggest that the area may contain numerous faults.

2.2.2 Lithology and Stratigraphy

The dominant lithologies in the Castle Rock GRA are medium to pale gray basalts and andesites of the Strawberry Volcanics. This unit ranges from olivine basalt at the base to dacite and rhyolite at the top. The Strawberry Volcanics and equivalent units cover 50 percent of the GRA.

The oldest rocks exposed in the area are Mesozoic intrusives that are located in the northwest portion of the GRA, near Ring Butte. These include Cretaceous diorite intrusive bodies of various sizes and geometries. Undivided Triassic and Jurassic sedimentary rocks outside the GRA are cut by Cretaceous dikes. Tertiary flows of the Clarno and younger formations overlie these rocks in the rest of the Castle Rock GRA.

Various intrusives, basalts, welded tuffs, and sedimentary rocks are exposed in the southern portion of the GRA. The youngest Tertiary volcanics are located near Castle Rock. Faults of unspecified age also are mapped in this area. Quaternary units in the Castle Rock GRA consist of alluvium and sedimentary valley fill.

2.2.3 Structural Geology

Major structural events that affected this part of Oregon include orogenic episodes and extensional movements accompanied by outpourings of flood basalts. The latter have obscured much of the earlier geologic history in the area. During the Pennsylvanian, this part of Oregon was mantled by regressive sandstones of the Spotty Ridge Formation in response to the Antler orogenic event that occurred farther south in Nevada.

Episodes of mini-plate acretions occurred during the Permian and Triassic in the eastern Blue Mountains, resulting in four sub-parallel belts of oceanic and forearc basin rocks. Late Jurassic to Early Cretaceous orogenic event is characterized in Oregon by strong folding, faulting, and regional metamorphism. Ultramafic bodies that are associated with the Idaho Batholith were emplaced at this time. This event was significant in that it was the driving mechanism for the concentration of valuable mineral deposits that occur in the Dixie Butte area.

Geologic Map
Castle Rock GRA
(OR-032-15)
Grant, Harney and Malheur Counties, Oregon

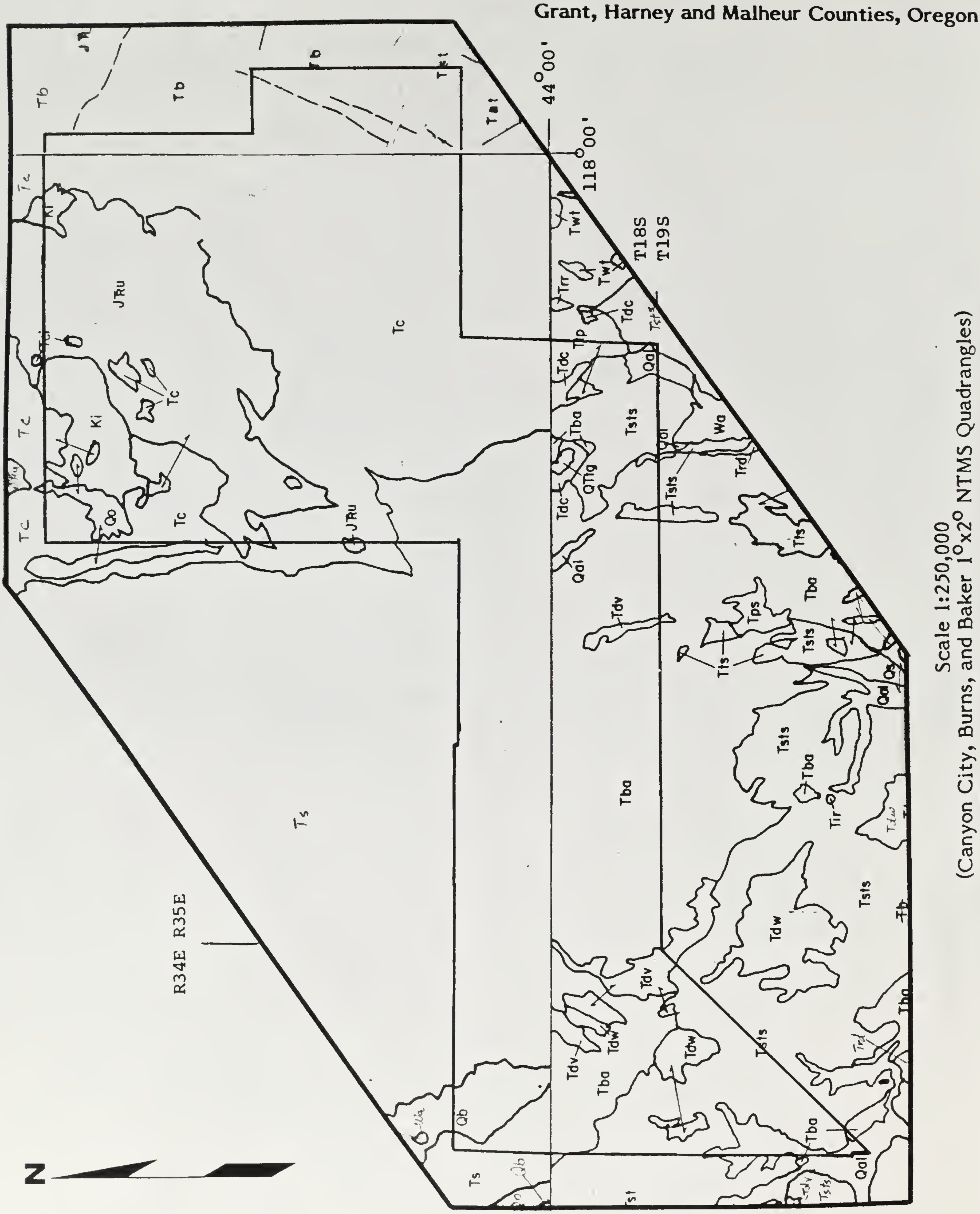

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FIGURE 2-2
(Continued)

Geologic Map Legend For
Castle Rock GRA
(OR-032-15)
Grant, Harney and Malheur Counties, Oregon

Baker
(North of 44°00' and East of 118°00')

Tst	- Tuffaceous Sedimentary Rocks: Poorly consolidated water-laid silicic volcanic ash, tuffaceous clay, siltstone, minor diatomite, mud-flow deposits, air-fall and ash-flow tuffs, and some coarse epiclastic deposits. Chiefly lacustrine except in the northern part of the map area where the upper part of the sequence includes gravelly fluviatile deposits.
Tat	- Ash-Flow Tuffs and Tuffaceous Sedimentary Rocks: Partly to densely welded silicic ash-flow tuff. Includes some non-welded tuff and tuffaceous sedimentary rocks.
Tb	- Basalt and Andesite: Chiefly flow-on-flow basalt. Includes some andesite flows, basaltic and andesitic flow breccias, palagonite tuff and breccia and minor silicic tuff and tuffaceous sedimentary rocks. The southwest part of the area includes some silicic flows at the top of the section.
JTri	- Plutonic Rocks: Upper Triassic. Lower Jurassic quartz diorite.

Canyon City
(North of 44°00' and West of 118°00')

Qo	- Older Alluvium: Includes terrace, pediment, and glacial outwash gravels, and boulder deposits above the present drainage system.
Qb	- Basalt and Basaltic Cinders
Ts	- Strawberry Volcanics: Mostly medium to pale gray basaltic andesite. Ranges from olivine basalt at the base to dacite and rhyolite at the top.
Tc	- Clarno Formation: Basaltic to rhyolitic flows, breccia, tuff, and volcanic conglomerate, with thin lenses of fine-grained water-laid ash; thick hornblende-bearing porphyritic andesitic to dacitic flows and breccia occur locally.
Tci	- Clarno Formation: Dikes and plugs.
Ki	- Dioritic Intrusive Rocks: Intrusive masses ranging in size from dikes to a batholith.
JTru	- Sedimentary Rocks, Undivided: Numerous dioritic dikes and sills, probably of Cretaceous age, are included.

FIGURE 2-2
(Concluded)

Geologic Map Legend For
Castle Rock GRA
(OR-032-15)
Grant, Harney, and Malheur Counties, Oregon

Burns
(South of 44°00' and West of 118°00')

Qal	-	Alluvium
Qs	-	Sedimentary Deposits
QTtg	-	Terrace Gravels
Tst	-	Tuffaceous Sedimentary Rocks, Basalt, and Welded Tuff: Tuffaceous sedimentary rocks.
Twt	-	Tuffaceous Sedimentary Rocks, Basalt, and Welded Tuff: Welded Tuff.
Tdw	-	Drinkwater Basalt
Tdv	-	Welded tuff of Devine Canyon
Tsts	-	Tuffaceous Sedimentary Rocks
Tir	-	Intrusive Rhyodacite
Ŧr	-	Rhyolite and Rhyodacite
Ttp	-	Tims Peak Basalt
Tts	-	Tuffaceous Sedimentary Rocks
Tba	-	Basalt and Andesite
Tps	-	Pumiceous Sedimentary Rocks
Ŧd	-	Rhyodacite
Tdc	-	Dinner Creek Welded Tuff
(heavy line)	-	Fault (dashed where inferred).
(thin line)	-	Geologic contact (dashed where inferred).

A eugeocline formed in the Middle to Late Mesozoic. This structure was the repository for tens of thousands of feet of Triassic and Jurassic sediments that are potentially favorable for the accumulation of oil and gas. Nevadan and Laramide orogenies at the end of the Mesozoic rotated this structure, forming what is now known as the Columbia Arc. At about the same time, the Klamath Mountains were thrust westward. Stratigraphic offsets suggest that rotation of the Columbia Arc continued into the Oligocene[9].

In eastern Oregon, northwest trending fault patterns resulted from extensional faulting similar to that in the Basin and Range Province. Some faults, such as the Brothers fault zone, curve northward near Bend, Oregon; this may be related to the rotational movements of the Columbia Arc.

2.2.4 Paleontology

The dominant lithostratigraphic units in the Castle Rock GRA are Tertiary volcanics that may contain fossils only in interbedded lacustrine units of restricted lateral extent. Tuffaceous sedimentary facies within Tertiary units (specifically the Clarno Formation) may contain vertebrate remains[10].

2.2.5 Historical Geology

The evolution of this area during Paleozoic and Early Mesozoic time is incompletely known because of the paucity of exposures. Devonian, Late Mississippian, and Permian limestones and shales suggest a transgressive-regressive sequence that developed in warm epirogenic seas. These strata were subsequently folded and faulted in Early Mesozoic time. Dynamothermal metamorphism and syntectonic intrusions further obscured the previous geologic history of these strata. The eroded roots of these Early Mesozoic structures are unconformably overlain by Late Triassic and Early Jurassic strata.

The Late Mesozoic and Cenozoic history of the area is much more clear. Two major tectonic features formed during this time. These were the Columbia Arc, which consisted of Paleozoic and Mesozoic rocks, and the Columbia Embayment, which was the locus of Cenozoic sedimentation and volcanic activity. The Columbia Embayment was a eugeoclinal trench that developed between the Klamath and Wallowa Mountains.

Thousands of feet of graywacke, lava flows, and volcaniclastic sediments were deposited in the Columbia Embayment. There was nearly continuous volcanism in the southwestern part of this trough. This is reflected in the thick sequence of volcanics near Willowdale and Ashwood[9]. Conversely, the northeastern part of the trough received only intermittent volcanics. Limestone reefs formed in this area during episodes of diminished volcanic activity.

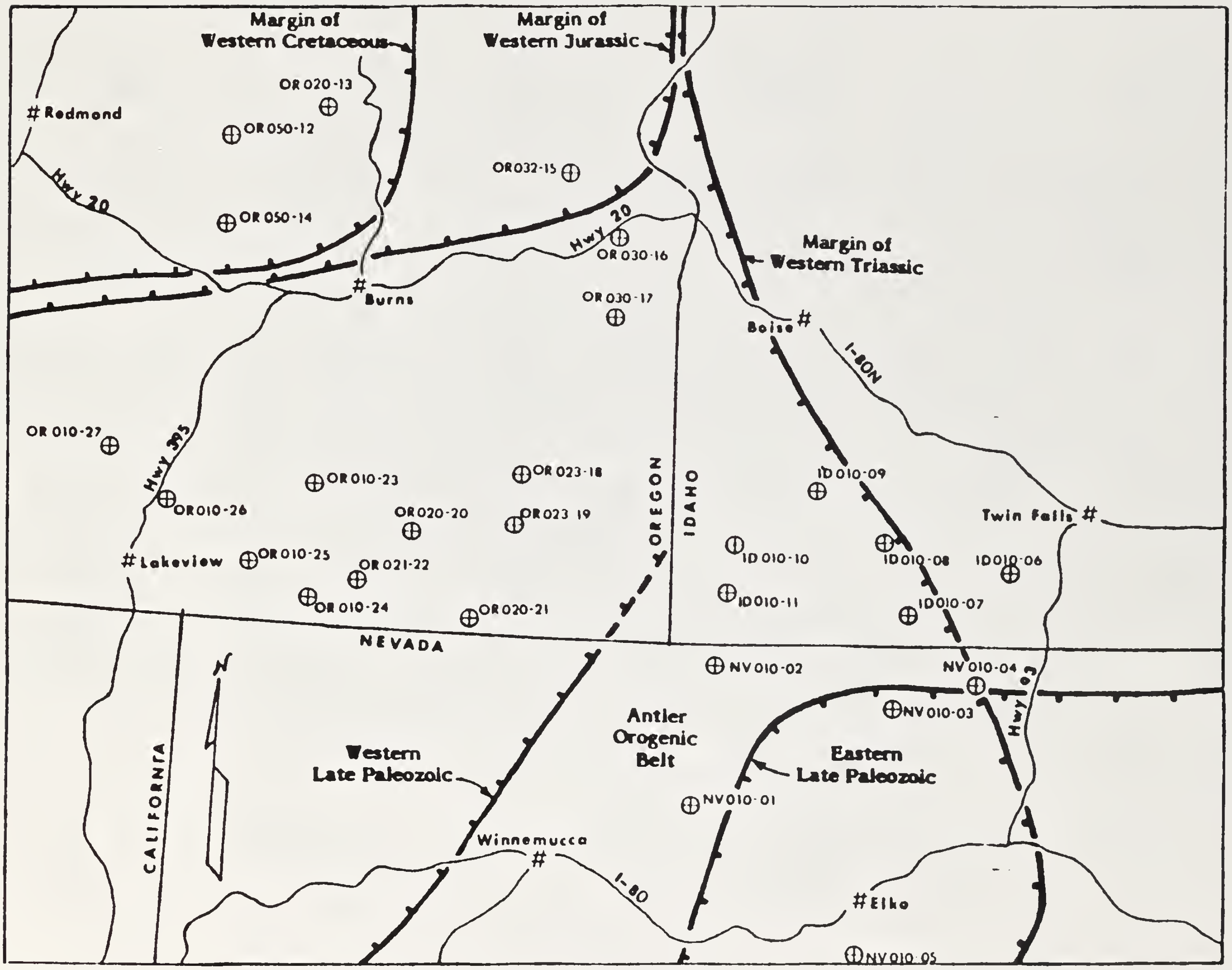
Upper Triassic and Jurassic strata compose fluvial, conglomerate, sandstones, siltstones, mudstones, and freshwater limestones. The Hyde Formation represents a minor marine transgression; it contains as much as 1,500 feet of marine sediments. The Mesozoic strata were subsequently folded and faulted during the Late Jurassic to Early Cretaceous orogenic event. Syntectonic intrusives and regional metamorphism accompanied this event. Most of the metalliferous mineralization in this part of Oregon is related to these intrusives.

The geologic evolution of Oregon was characterized by continued uplift and volcanism during Cenozoic time. In western Oregon volcanics filled the remaining geosynclines. Sporatic eruptions of basalt and rhyolite in the Paleocene dammed streams and filled basins in central Oregon. Central and western Oregon were blanketed by lava flows and pyroclastic deposits from the emerging Cascades. In the Miocene, basalt flows in northern Oregon covered 100,000 square miles, forming the Columbia River Basalt Plateaus. The southern Blue Mountains contained basaltic and rhyolitic volcanoes that eventually inundated them with thick volcanogenic deposits.

The tropical climate during the Tertiary was condusive to the development of limonite and lateritic bauxites on the flat basaltic plateaus in western Oregon. By Pliocene time, nearly all of Oregon was above sea-level. The climatic differentation became more pronounced as a result of further development of the Cascades.

FIGURE 2-3

Paleogeographic Map[11]
Oregon-Idaho-Nevada
Tri-State Area



2.3 ENVIRONMENTS FAVORABLE FOR GEM RESOURCES

The Castle Rock GRA contains environments that are favorable for the occurrence of geothermal, diatomite, agate, and oil and gas resources.

The GRA is classified moderately favorable (3B) for the occurrence of oil and gas resources. The GRA is located within the limits of Jurassic and Triassic marine sedimentation[11]. Both of these systems may contain environments favorable for the accumulation of oil and gas. The estimated depth to potentially favorable horizons is unknown. The area is moderately favorable (Class 3) for the occurrence of diatomite and agate resources[12]. Occurrence of both of these resources occur within about ten miles of the GRA. Analogous environments occur in the Castle Rock GRA. The presence of Beulah Hot Springs, just south of Castle Rock, the convergence of north trending faults, and the presence of young volcanics make the environment potentially favorable (3C) for geothermal resources. Most of WSA 3-18 is included in this moderately favorable area[13].

All other environments within the Castle Rock GRA are rated as least favorable to only slightly favorable for the occurrence of other GEM resources. The low favorability classifications for resources other than geothermal, diatomite, agate, and oil and gas are based on the fact that the requisite geologic environments are not known to exist and/or the geologic processes essential for the accumulation of mineral resources cannot be demonstrated to have occured in the area.

2.3.1 Environments for Metals Resources

The Castle Rock GRA contains no environments that are considered favorable for the accumulation of metallic resources[14]. Requisite geologic environments and evidence of mineralizing processes do not exist within or near the GRA.

2.3.2 Environments for Oil and Gas Resources

The Castle Rock GRA is moderately favorable for the occurrence of oil and gas resources. Potentially favorable environments include Triassic and Jurassic marine sedimentary units[15]. Favorability is enhanced by the occurrence of multiple potentially favorable hosts.

2.3.3 Environments for Oil Shale and Tar Sands Resources

The Castle Rock GRA contains no environments that are favorable for the occurrence of oil shale or oil impregnated sand[16]. The area is underlain predominantly by Tertiary volcanics of felsic to ferromagnesian composition. Potential sedimentary hosts are largely tuffaceous and contain only minor amounts of non-volcanic clastic material and carbonates. Favorable lithologies are not present.

2.3.4 Environments for Geothermal Resources

The Castle Rock GRA contains an environment that is moderately favorable for geothermal resources. Requisite geologic criteria are present in the area[13]. There is an occurrence of hot (185°F) spring activity at the north end of the Beulah Reservoir. Other favorable criteria are the presence of young volcanics and the convergence of major fault zones near Castle Rock.

2.3.5 Environments for Uranium and Thorium Resources

The Castle Rock GRA contains no environments that are favorable for the occurrence of uranium or thorium[17]. The GRA does not exhibit any of the lithology, alteration, or geochemical recognition criteria for environments that may be favorable for uranium or thorium. There are no uranium occurrences in or near the area; and no evidence to indicate the presence of uranium or thorium in association with any other mineralization.

2.3.6 Environments for Coal Resources

The Castle Rock GRA has a low favorability rating for the occurrence of coal and lignite deposits[15]. The chances for coal or carbonaceous materials to have formed in the study area are remote. The geology of the Castle Rock GRA does not support environments favorable for the formation of coal deposits. Much of the area is either mantled with accumulations of lavas and related volcanic products or has been modified by adjacent volcanic activity.

2.3.7 Environments for Industrial Minerals Resources

Diatomite occurs in nearby townships in lacustrine sedimentary environments that are analogous to those environments found within the Castle Rock GRA. This implies a likelihood for this resource in the GRA. Agate is found about ten miles southwest of the GRA(12). similar environments may exist within the GRA.

2.3.8 Environments for Paleontological Resources

The Castle Rock GRA contains environments that have low favorability for paleontological resources. No fossil localities or occurrences are known to occur in the area(10).

2.3.9 Environments for Geologic Hazards

Potential geologic hazards in the Castle Rock GRA consist of mapped and interpreted faults, landslides, and/or volcanic centers(12). These features were noted from aerial photographs, geologic maps, and topographic maps. There is no historical record of violent seismic or volcanic activity in the area. The potential for mass movement exists along all over-steepened slopes within the GRA.

2.3.10 Educational and Scientific Localities

There are no known ESLs in the Castle Rock GRA.

3. ENERGY AND MINERAL RESOURCES IN THE CASTLE ROCK GRA

The overall favorability of the Castle Rock GRA for GEM resources is low, with the exception of oil and gas, geothermal resources, diatomite, and agate.

3.1 KNOWN DEPOSITS

The Castle Rock GRA has no known deposits of GEM resources.

3.2 OCCURRENCES

The Castle Rock GRA contains no CRIB, MILS, or NURE-related occurrences.

3.3 CLAIMS

The Castle Rock GRA contains three mining claims in the northwestern and southwestern parts of the GRA (Figure 3-1). Claims data are current as of 15 August, 1982.

3.4 LEASES

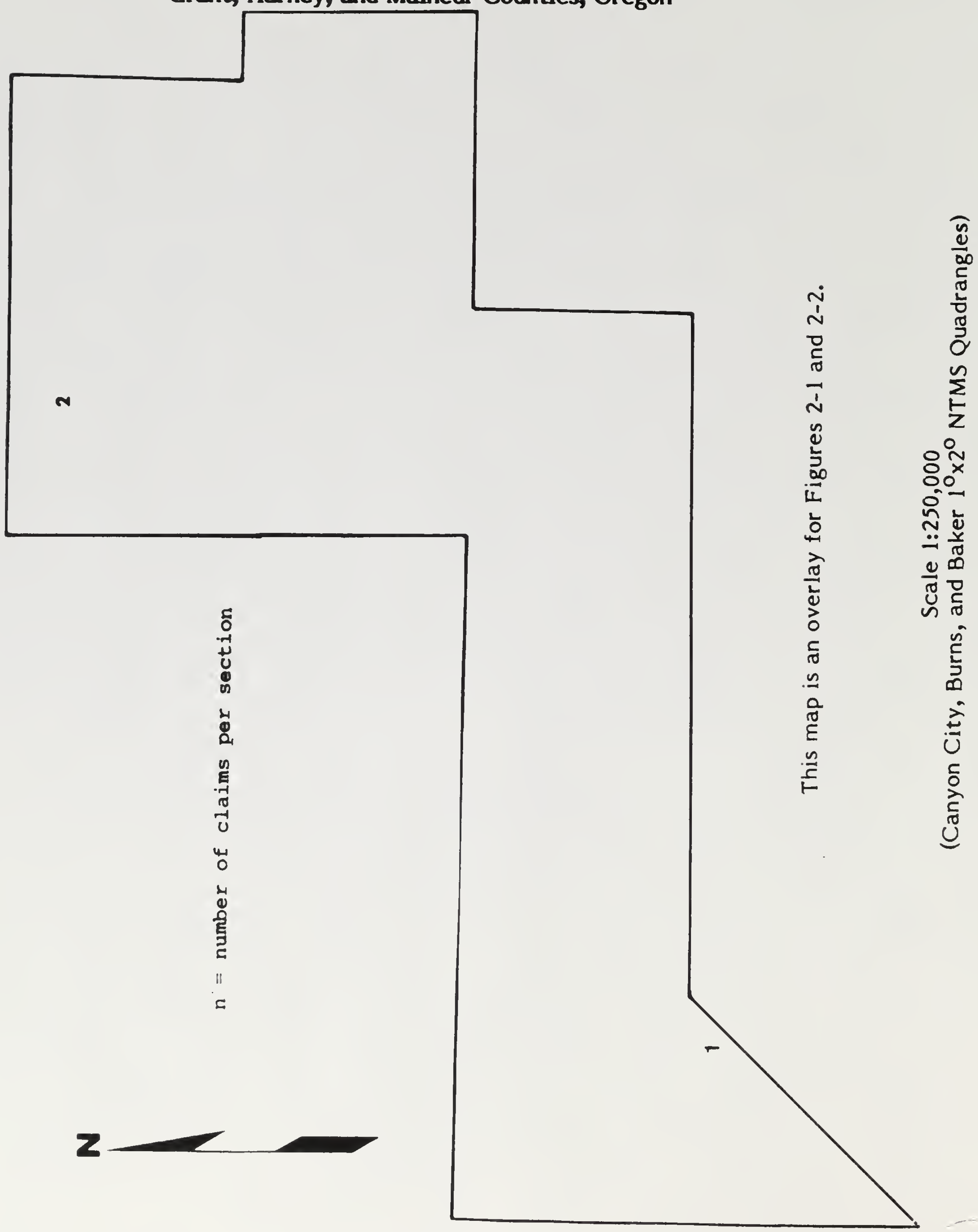
Approximately 90 percent of Castle Rock GRA is leased or is under lease application for oil and gas. Lease information is current as of 15 August, 1982.

3.5 DEPOSIT TYPES

There are no known deposits within the Castle Rock GRA.

FIGURE 3-1

Claims Density Map
Castle Rock GRA
(OR-032-15)
Grant, Harney, and Malheur Counties, Oregon



3.6 MINERAL ECONOMICS

The Castle Rock GRA is moderately favorable for the occurrence of oil and gas, geothermal, and diatomite resources.

3.6.1 Oil and Gas

Oil and gas are vitally important to the industrial growth and development of the United States, and to the overall standard of living. Gross supply and demand trends indicate that during the present decade foreign oil will make up at least 45 percent of our national oil requirements. Present domestic production is 8.6 million barrels per day. The United States currently has a 37 million barrel per day equivalent energy demand. It is predicted that by 1990 the United States will produce 8.8 million barrels of oil per day. The equivalent energy demand will increase to 40 million barrels per day[18]. During this same period, crude oil demand will decrease by nearly 5 percent, from 16 million barrels per day to 14 million barrels per day equivalent. This decrease is thought to be related to an increase in the use and development of other domestic energy sources, consumer conservation practices, and a predicted slight increase in crude oil production by 1990[18]. Because most shallow sources of crude have been or are being depleted, deeper, more difficult targets of oil and gas are being sought. This may result in a rise in the price of crude by 1990 to $61.00 per barrel[18]. This may reverse the trend of surplus supplies that began last year. It also may cause shortages[19].

3.6.2 Geothermal

Geothermal resources may be classified into two general categories; low-temperature resources (96°F to 196°f), and high-temperature resources (196°f to 302°F). Uses of low-temperature geothermal resources include local industrial, agricultural, and domestic heating applications. High-temperature geothermal resources currently are used only in limited commercial electrical generation and research applications. Supply, demand, and price data are not established for this resource because of the limited amount of production. The importance of geothermal resources is generally of a local nature[13].

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3.6.3 Diatomite

Diatomite is used primarily as a filter-aid, as an industrial filler, and other miscellaneous applications, including insulation[20]. Diatomite was produced by seven companies in four states in 1981[21]. California accounted for more than 50 percent of total diatomite production. The United States is the largest world producer and consumer of diatomite. The United States also is a net exporter of this commodity. Demand for diatomite is expected to increase at an annual rate of three percent through 1990. World resources of diatomite are adequate for the foreseeable future, but the need for near-market sources will encourage development of new sources.

3.7 STRATEGIC AND CRITICAL MINERALS AND METALS

The Castle Rock GRA is not favorable for any strategic or critical metals or minerals as listed in the BLM-supplied compilation given in Table 3-4 of the TERRADATA report entitled "Procedures for the Assessment of Geology, Energy, and Minerals (GEM) Resources."

4. CLASSIFICATION OF LAND FOR GEM RESOURCES POTENTIAL

The precise location of specific favorable environments within a given GRA depends upon three principal factors:

- The precision and specificity of avaliable data;
- The nature (size and spatial distribution) of anticipated deposits as predicted from known models; and
- The geometry of the favorable geologic environments.

Commodity-specific information in the Castle Rock GRA is limited. Sub-surface information is virtually non-existent. Therefore, with the single exception of geothermal resources, the entire area, rather than specific subareas, has been classified for individual GEM resources (Figure 4-1 and Table 4-1).

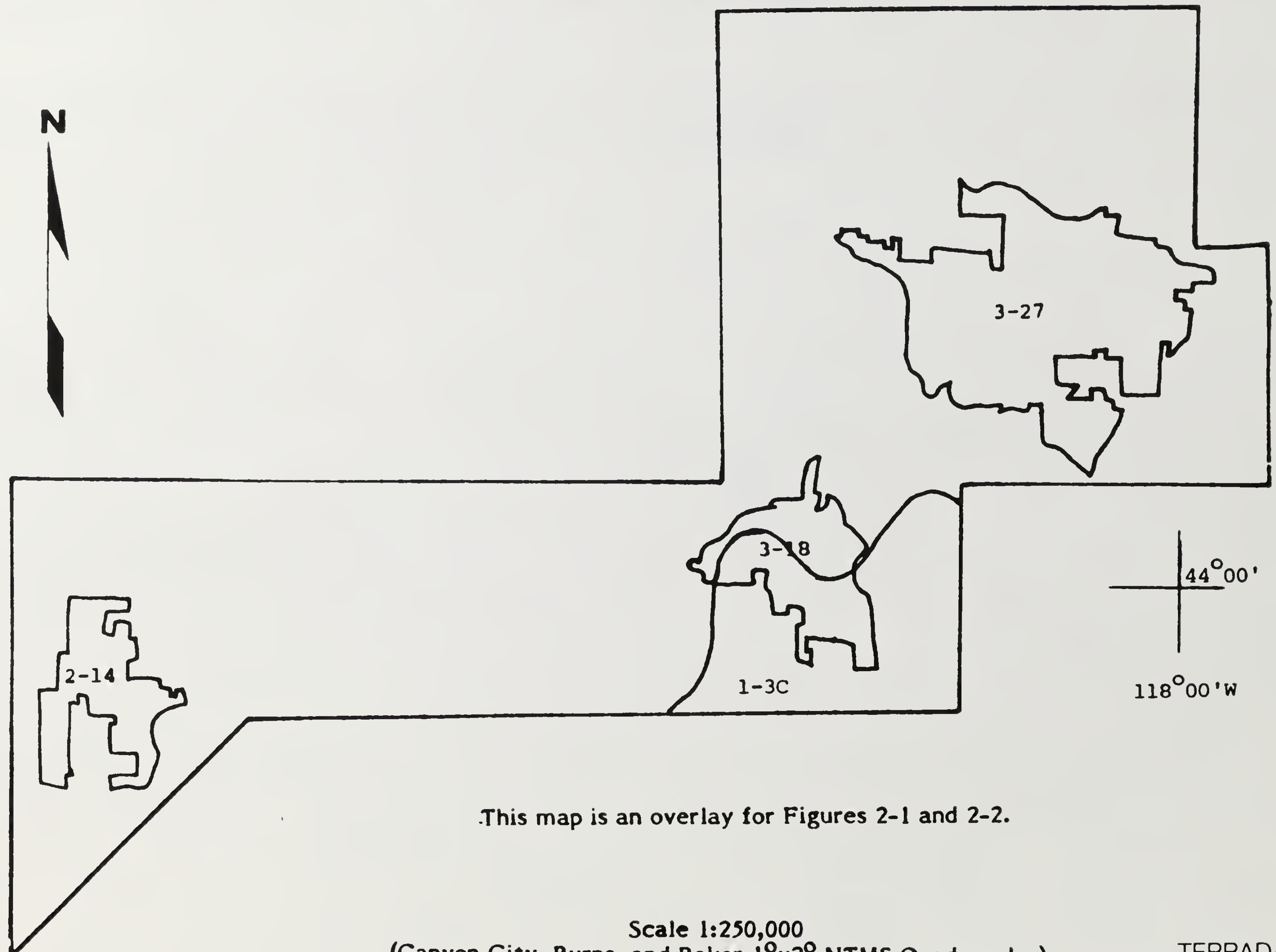
The entire Castle Rock GRA is moderately favorable (Class 3B) for potential oil and gas resources because it is underlain by the appropriate geologic environments[8]. It is within the limits of the western Jurassic and Triassic marine basins. The marine rocks are overlain to an unknown depth by Tertiary continental and volcanic strata. The confidence level (B) of this classification signifies that the available data provide indirect evidence for the existence of this resource.

The Castle Rock GRA has a moderate favorability (Class 3) for the occurrence of diatomite and agate[6]. These minerals are common in lacustrine and volcanic terranes. Diatomite deposits are known to occur near the area. The confidence levels for the evaluation of these resources are A because, while the GRA contains favorable environments for both diatomite and agate, there is lack of sub-surface information or other direct or indirect evidence to support this classification.

The Castle Rock GRA is classified moderately favorable (3C) for geothermal resource potential. The southern portion of WSA 3-18 is included in the favorable area for this resource. There is a 185°F hot spring just south of the GRA near Beulah Reservoir. The convergence of north-trending faults in this area, and the presence of young volcanics near Castle Rock also are favorable indications of geothermal resource potential. TERRADATA's classification of this area for geothermal resource potential is in agreement with the USGS classification for the same resource.[22].

FIGURE 4-1

Land Classification Map
Castle Rock GRA
(OR-032-15)
Grant, Harney, and Malheur Counties Oregon



This map is an overlay for Figures 2-1 and 2-2.

Scale 1:250,000
(Canyon City, Burns, and Baker 1°x2° NTMS Quadrangles)

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Table 4-1

Classification Of Lands Within The Castle Rock GRA (OR - 032 - 15) Grant, Harney and Malheur Counties, Oregon For GEM Resource Potential

COMMODITY	AREA	CLASSIFICATION LEVEL	CONFIDENCE LEVEL	REMARKS
Metals	Entire GRA	1	A	
Geothermal	Area 1-3C	3	C	
	Rest of GRA	1	B	
Uranium/Thorium	Entire GRA	1	A	
Coal	Entire GRA	2	B	
Oil and Gas	Entire GRA	3	B	
Tar Sands/Oil Shale	Entire GRA	1	C	
Limestone	Entire GRA	1	C	
Bentonite	Entire GRA	2	A	
Diatomite	Entire GRA	3	A	
Clinoptilolite	Entire GRA	2	C	
Agate	Entire GRA	3	C	
Paleontology	Entire GRA	2	A	
Hazards	See Hazards Map (GRA File)			
ESLs	None	1	C	

LEGEND:
Class 1 - Least Favorable
Class 2 - Low Favorability
Class 3 - Moderate Favorability
Class 4 - High Favorability

Confidence Level A - Insufficient data or no direct evidence
Confidence Level B - Indirect evidence available
Confidence Level C - Direct evidence but quantitatively minimal
Confidence Level D - Abundant direct and indirect evidence

The Castle Rock GRA has low favorability (Classes 1 and 2) for metals and non-metals, uranium and thorium, coal, tar sands and oil shale, limestone, bentonite, clinoptilolite, and paleontological resources because the geologic environments and the inferred geologic processes do not indicate favorability for the accumulation of these resources.

TERRADATA's evaluation of the Castle Rock GRA is in agreement with the USGS evaluation of the area for the same leasable commodities.[22, 23, 24].

5. RECOMMENDATIONS FOR FUTURE WORK

Further surface geologic investigations, including detailed mapping and stratigraphic studies, would enhance the confidence levels of many of the classifications in the Castle Rock GRA. It is doubtful, however, that the original classifications would change substantially. Sub-surface investigations are probably not warranted in this area due to the costly nature of the available methodology. Geophysical and geochemical surveys might provide some insight into the potential resources of the study area. Geophyscial surveys might help to delineate structural traps for potential oil and gas resources.

- APPENDIX A -

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